RESEARCH HIGHLIGHTS

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INTEGRATED DESIGN CHARRETTE FOR A SUSTAINABLE UNIVERCITY COMMUNITY

Introduction

Proposed developments for UniverCity, a wholly owned subsidiary of Simon Fraser University (SFU) in Burnaby, British Columbia, involves the creation of a complete, sustainable community on Burnaby Mountain. An eventual population of about 11,000 people will adjoin SFU's mountain top campus. It is hoped that a portion of residents will be employees and students at SFU.

Because the site is away from the surrounding urban area, it must develop quickly into a complete community. Plans for the first four sites will set the tone for the entire community and include a low-rise, multi-family unit project and two mid-rise residential projects.

The site is steeply sloped, ranging from six to 30 per cent grade. It contains a range of mature trees, and there are designated riparian areas. While the designs for UniverCity are to reflect sustainable principles, significant departure into new territory is not advisable for enticing residents to a relatively remote area. Instead, modest improvements will set the stage for future advances in incorporating sustainable features.

To support the development of a more sustainable community, 49 people participated in a two-day integrated design charrette held in September 2002. The charrette provided the opportunity for three developers, their design teams and resource expertise from various disciplines to explore ways of incorporating UniverCity's Green Building Guidelines into the three residential development proposals. The participating development teams were from Millennium, Intergulf and Polygon.

Experts with experience in the integrated design process (IDP) acted as facilitators and provided support to the design teams. Resource people complemented the developers' design teams, bringing expertise as quantity surveyors, landscape specialists, sustainability consultants, solar energy advisors, municipal regulators and utility representatives.

The benefits of IDP are that it allows for greater team interaction in the early stages of design, encouraging participants to see a building as an integrated set of systems; it uses sophisticated modeling tools to examine energy efficiency options; and it brings together experts reflecting a broad range of experience, including advanced technologies, indoor air quality, material selection, commissioning and so forth.

Keys to a successful IDP

- Introduce all team members to the process and have them responsible for establishing performance goals at a building's concept stage.
- Ensure teams are multi-disciplinary and include a design facilitator and an energy simulator.
- Have team members share knowledge and test ideas together, thereby developing greater respect and under standing for each other's points of view.
- Have teams conduct all aspects of design in a methodical manner.
- Participants must be willing to think "outside the box" and consider all options, no matter how outlandish they may seem at first.

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The Charrette

Plenary session

The opening plenary provided an overview of design goals and included presentations on key topics: IDP; green and energy efficiency issues in buildings; design technologies aimed at reducing moisture problems in building envelopes; multi-residential building issues; storm water management issues; and marketing issues.

The top of buildings generally experience the greatest wetting forces, so roof design and detailing have a significant impact on the overall performance of building envelopes. Rainscreen wall systems help to minimize wind pressure forces acting on the envelope, thereby reducing the amount of surface moisture driven into building envelopes by wind.

The three development sites are part of the headwaters of Stoney Creek, an important urban salmon stream. The best way to manage storm water runoff is directly on-site. Sustainable approaches include allowing rain to penetrate into the ground to provide moisture for plants, storing and using rainfall for summer irrigation and water retention features, and delaying the rate of runoff by detention.

Green roofs can be another effective storm water management tool, acting as dampers on peak flows. For Burnaby Mountain, vegetated green roofs might handle 10 to 20 per cent of storm water volumes. Because of the uniqueness of each site, it is not possible to create prescriptive solutions; instead, water use principles need to be applied and specific targets in on-site water management should be set.

Determining a building's energy efficiency performance is critical and is easily done using energy simulation software. If performance targets are not met, or a design team wants to explore alternative measures, design elements can be adjusted and the design retested. In this way, a team can determine how proposed changes affect overall energy consumption and efficiency.

Following the plenary session, the three teams broke into separate group sessions. Facilitators and energy simulators led them in exploring options and strategies to improve the energy efficiency of their buildings.

Millennium

Millennium's proposed design is for two mid-rise residential towers, with about 76 units per building, one of which includes townhouses. Total buildable area, including parking, is about 12,077 m2. It is anticipated the layouts will include two bedrooms and a den, two bedrooms, one bedroom and some units with potential secondary suites. Parking could be reduced to a minimum of 1.6 spaces per unit, but not less.

The design is similar to other Millennium projects in the area, with large windows on low sills and cast-in-place concrete with insulation on the inside of the wall. The developer expressed concern about a stepped building design, which is encouraged by the design guidelines, because it is difficult to insulate with cast concrete construction.

The team's goals were to improve the energy efficiency of the building and to create comfortable, healthy indoor environments. The group discussed market, site, design, recycling and resource-efficient aspects of their project.

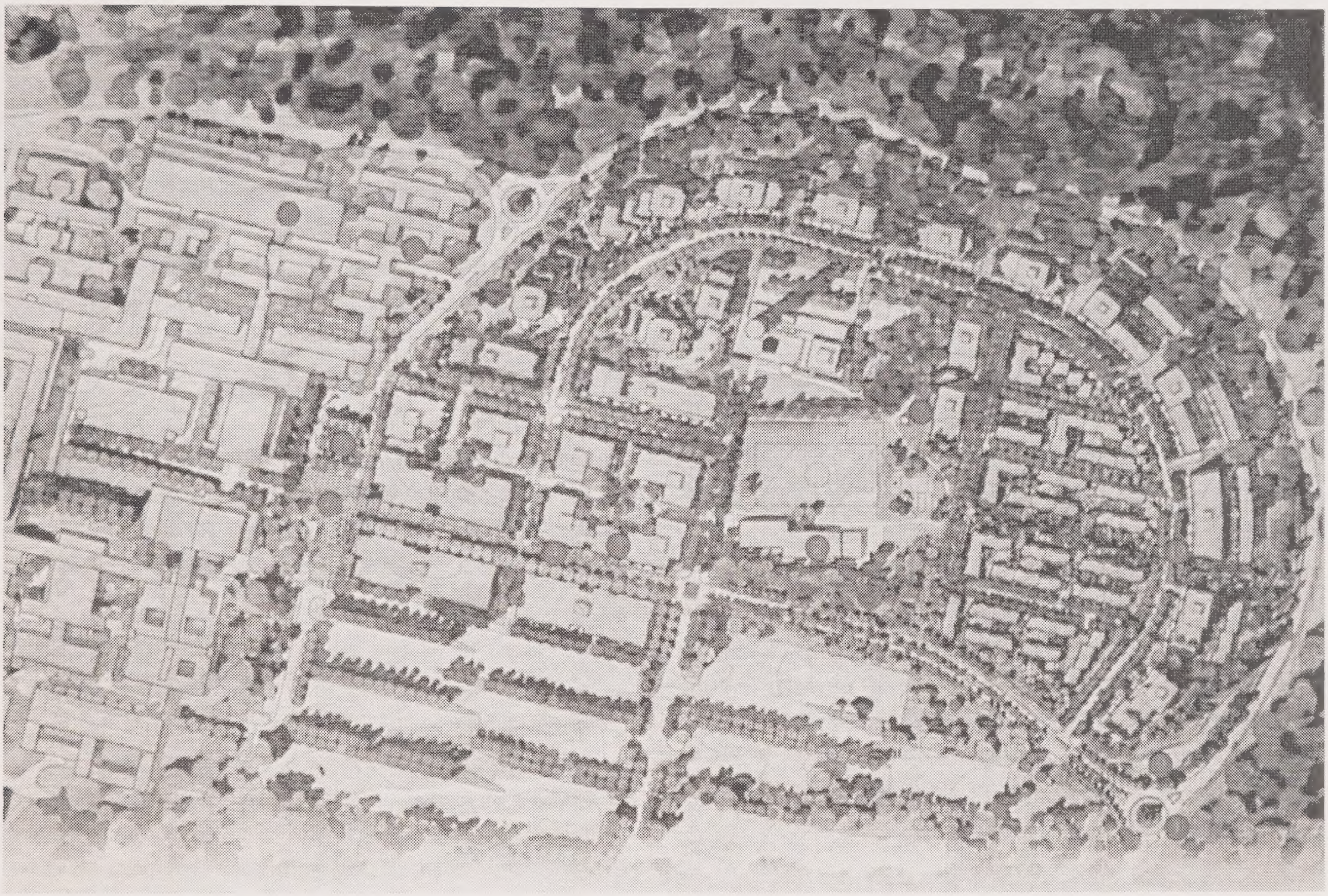
Of key concern to the developer was the need to identify the potential market for the building. If they used the typical sales price for condominium units in Greater Vancouver, the units would be out of reach for first-time buyers at $240,000. Instead, Millennium wanted a mid-range selling price near that of similar units in the surrounding Burnaby market.

Marketing research shows that flexible design, indoor air quality and energy efficiency are important to home buyers in BC, with strictly green features being less significant. The team noted it should promote indoor air quality aspects and the use of ventilation systems and low-emission materials. Other key selling features would be increased comfort through the possible use of HRV systems, higher performance low-E glazing, cross-ventilation and a rainscreen wall system.

Energy-efficient design favours smaller units, because a 10 to 15 per cent reduction in energy use can be achieved. However, local municipal development cost charges penalize smaller suites as there is no differentiation for unit size. There was cautious interest in a flex design for some suites to permit subdivision into a self-contained secondary suite. Reservations had to do with assessing strata fees on rental suites and a perception that some condominium owners would not be receptive to rental units within the building.

Energy simulations on the design indicated that the building would have no problem meeting the Model National Energy Code for Buildings (MNECB) or ASHRAE 90.1. However, the project would have difficulty meeting Natural Resources Canada's Commercial Buildings Incentive Program (CBIP) without an HRV in each unit and reducing the overall window-to-wall ratio.

The team discussed the possibility of designing a greener roof, using a shallow soil covering of less than 10 cm for grasses and mosses. This is similar to what is done in Germany. While this will not greatly reduce runoff, it will reduce the flow rate. There were concerns, though, that the roof would be filled with alder seeds, which are prolific on SFU campus, and the invasive roots of this species can lead to damage. The team agreed there is a positive insulating value with a green roof, but decided it would not be advantageous to have a green roof on this site.



Artist's illustration of the UniverCity Highlands Neighbourhood

Highlights of the Plan

1. *The Roundabout* - This attractive landscaped gateway to the community will also help reduce vehicle speeds.
2. *Elementary School & Park* - A centrally located elementary school and park is planned in the early stage of development of the Highlands neighbourhood.
3. *Childcare Facilities* - New childcare facilities will serve neighbourhood residents.
4. *UniverCity HighStreet* - A village style main street with a charming mix of retail, office and residential space.
5. *Redesigned Bus Loop* - Forming parts of the Town Square, it will include a stop for a new shuttle service connecting to the SkyTrain station at the base of the mountain.
6. *Town Square* - A place where "town meets gown." A lively centre of activity and fascinating blend of small cafés, offices, and academic space.
7. *Path Network* - An extensive network of pedestrian pathways and cycling paths linking the new community with the campus and surrounding conservation area.
8. *Trees & Greenways* - Extensive tree retention along University Drive. New greenways will be created by heavy replanting of native tree and shrub species.
9. *Protecting Natural Heritage* - Comprehensive watercourse and stormwater management systems protect riparian areas, mountain creeks and other environmental features.
10. *UniverCity Crescent* - A gently curving residential street featuring deciduous trees that create a leafy canopy effect over the roadway.
11. *Campus Expansion* - Areas within the Ring road have been set aside for academic use and future campus expansion.
12. *New Parking Facilities* - New university parking structures will be built in place of existing surface lots.

Heating and ventilation systems were discussed at length. It was suggested that a centrally located hydronic system could be tied into a campus-wide district heating system. The drawback is that it would result in an incremental cost of about $300 per unit. Although prices have dropped for active solar electric systems, they are still expensive from a cost recovery perspective. The design team concluded that solar retrofits would be easier to do in the future, once the technology has become more price-efficient.

Heat recovery ventilators (HRVs) offer no direct payback to the developer, as the economic benefit goes to the occupants. To ensure sufficient ventilation, the team proposed a dedicated make-up air system using heat from the refrigerator coil to warm incoming external air from a fan system. This would be coupled with a positive pressure system in the hallways. It was thought that a HRV system to pre-warm corridor air with exhaust air gathered from suites would not work in this type of project.

Regarding other design features, the team noted that a window curtain wall could be used to achieve greater energy efficiency but this would increase costs. Suite-to-suite noise transmission might be overcome by using an acoustic separation system in the floors. Water use could be improved by collecting rainwater for domestic use, but this is currently not permitted, and the development guidelines have no requirement for double plumbing in buildings. Future development in the UniverCity Highlands may provide for this.

Some other suggestions included reducing the amount of construction waste generated; separating construction waste into recyclable and non-recyclable material; limiting topsoil disturbance and storing on-site; using fly ash content concrete; using local brick and stone where possible; and using low-emission finishes and products.

Intergulf

The preliminary building design is for a floor area of 15,967 m2 in two eight-storey buildings, plus some two-storey townhouses, for a total of 151 units in an all-concrete building. Parking will be provided at 1.4 spaces per unit.

This team's goals were to 1) meet CBIP's energy consumption target, which is 25 per cent less than MNECB; 2) be resource efficient, optimizing the use of recycled content materials and reducing construction waste; and 3) achieve a healthy indoor environment through the careful selection of materials.

Situating the parking structure on the downhill slope would allow daylight to enter the parking area. This would reduce energy needs for lighting and ventilation, but it could conflict with municipal regulations for building area and massing calculations.

Trees that are removed should be milled for on-site landscaping, and excavated rocks and boulders should similarly be used for landscaping and terracing.

Suggested water control options included use of shallow water features to promote evaporation, bio-swales and terraces to slow runoff, gravel and sand recharge filters, roof and deck plantings, a green roof, rainwater absorption landscaping and porous materials for public pathways. Roof leaders could be directed to recharge cells for dispersion and irrigation. Controlled discharge from cisterns should include irrigation of the forest area. Less than 50 per cent of the landscaping will be grass, to reduce the need for irrigation.

Not all envelope materials had been selected, but brick was being considered for the lower units, with an exterior insulation and finish system (EIFS) rainscreen cladding for the remainder of the buildings. The team decided to upgrade overall wall insulation levels to RSI 4.2 and the roof to RSI 3.4. The windows were upgraded to a thermally broken aluminum frame with hard coat low-E glass. Modeling during the charrette indicated these upgrades would result in an energy use reduction of 21 per cent. Given these results, the team thought that a 25 per cent reduction target could be easily achieved. In fact, some further changes such as reducing window areas to 40 per cent of the wall area, choosing a higher efficiency make-up air and ventilation strategy and energy-efficient lighting, achieved energy savings of 34 per cent.

Appliances, including front-load washers, motors and pumps will all be energy efficient. Compact fluorescent lights will be used in the hallways. Units will be individually metered and will have programmable thermostats. To optimize space heating, a high-efficiency gas central condensing boiler will be installed. Downsizing the electrical heating could result in a $50 per unit cost savings. Corridors will be pressurized with make-up air preheated by the exhaust from a central HRV. Ground source heat pumps for the townhouses might be viable if drilling costs can be shared. Photovoltaics were rejected because of long payback periods. Passive solar options, however, were not considered.

The team discussed individual suite HRVs, which would improve air quality in bedrooms, and the option of a central HRV system. The latter was estimated to cost less than half that of individual suite HRVs at $800 per unit compared to $1,700 per unit.

Other healthy indoor environment options included the use of low-emission materials, such as low volatile organic compound (VOC) paints, clay tile floors, sealed finishes, prefinished hardwood floors, and sealed combustion furnaces and boilers.

Polygon

Planning for this project was at an advanced stage at the time of the charrette. The development is a four-storey, terraced, wood-frame complex with 175 units in three buildings. All have two- and three-bedroom units with a few having a lock-off option for internal suites. Most units will be apartments, but there may be six to eight townhouse dwellings. The building has a shallow-pitched roof (4:12) in keeping with the developer's corporate design guidelines. Underground parking will provide 1.3 spaces per unit, the lowest of the three projects.

The team's charrette goals were to 1) minimize site disturbance; 2) retain the natural environment where possible; 3) attain a CBIP energy performance level (25 per cent less than MNECB); improve indoor air quality in the units; 4) optimize on-site storm water management; 5) enhance recycling facilities; and 6) meet project budget while achieving affordablility, short payback periods and low incremental costs.

Considerable discussion was given to building placement and on-site storm water management. The original design had a large retaining pond which also required an expensive holding tank structure. It was decided to reduce the size of infrastructure required by separating holding areas into several locations. Other water conservation features included aerators and low-flow toilets and showerheads, which were also considered by the other two teams.

This team likewise considered energy-efficient appliances, including front-load washers, and compact fluorescent lamps for common areas. They also discussed radiant heating, in-suite combination heating units, gas fireplaces (70 per cent efficient) in the living rooms and electric baseboards in the bedrooms, and photocells and a time clock for exterior lighting. Photovoltaics were briefly considered, but considered too costly for this type of project.

Envelope insulation levels were increased to RSI 2.71 for walls, with a maximum 40 per cent window to wall area, and RSI 7 for the roof. Modeling indicated a reduction of 15.5 per cent from MNECB standards, using off-the-shelf technologies with a rough estimate of 3.5 per cent increase in construction costs. The general conclusion of the team was that for the four-storey, wood frame building there was not much room for energy efficiency upgrades to meet CBIP requirements.

Ventilation and indoor air quality issues regarding suite and corridor ventilation and humidity control were discussed. As in the other two teams, individual suite HRVs, operable windows and low-emission finishes and products were considered.

Conclusions

The charrette as a whole demonstrated the success of the integrated design process, including the use of energy simulation software. It allowed the teams to deal with a complex set of issues quickly and to reach performance goals with the use of relatively few measures.

Polygon's project manager noted that while the charrette had been a good experience, the two-day session was an expensive commitment for their team. He suggested the work could be accomplished in one day with more focusing and better advance preparation of the teams.

For this charrette, CBIP's software was accessed through a web link. As the link was not operating properly, it caused delays in obtaining results. It is recommended that software be resident in computers used in a charrette to avoid such problems.

The charrette provided development teams with the opportunity to modify their original design proposals for UniverCity. Participants felt they gained a new perspective and valuable feedback on their proposed projects. The experience proved practical and rewarding.

Project Manager: Sandra Marshall
Research Report: *Integrated Design Charrette for a Sustainable UniverCity Community, 2002*
Research Consultant: Richard Kadulski, Architect

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Canada Mortgage and Housing Corporation
700 Montreal Road
Ottawa, Ontario
K1A 0P7

Phone: 1 800 668-2642
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